The Hybrid Power Management (HPM) Program

Hybrid Power Management (HPM) is the innovative integration of diverse, state-of-the-art power devices in an optimal configuration for space and terrestrial applications. The appropriate application and control of the various power devices significantly improves overall system performance and efficiency. The advanced power devices include ultracapacitors and photovoltaics. HPM has extremely wide potential with applications from nanowatts to megawatts. Applications include power generation, transportation systems, biotechnology systems, and space power systems. HPM has the potential to significantly alleviate global energy concerns, improve the environment, and stimulate the economy.

One of the unique power devices being utilized by HPM for energy storage is the ultracapacitor. A capacitor is an electrical energy storage device consisting of two or more conducting electrodes separated from one another by an insulating dielectric. An ultracapacitor is an electrochemical energy storage device, which has extremely high volumetric capacitance energy due to high surface area electrodes, and very small electrode separation. Ultracapacitors have many advantages over batteries.

- Batteries can only be charged and discharged about 300 times, and then must be replaced. Ultracapacitors can be charged and discharged over 1 million times. The long cycle life of ultracapacitors greatly improves system reliability, and reduces life-of-system costs.
- Long ultracapacitor life significantly reduces environmental impact, as ultracapacitors will probably never need to be replaced and disposed of in most applications.
- The environmentally safe components of ultracapacitors greatly reduce disposal concerns.
- High ultracapacitor power density provides high power during surges, and the ability to absorb high power during recharging. Ultracapacitors are extremely efficient in capturing recharging energy.
- Ultracapacitors are extremely rugged, reliable, and maintenance free.
- Ultracapacitors have excellent low temperature characteristics.
- Ultracapacitors provide consistent performance over time.
- Ultracapacitors promote safety, as they can easily be discharged, and left indefinitely in a safe discharged state.

HPM has been successfully applied to the NASA Hybrid Electric Transit Bus (HETB) project. This is a 40-foot transit bus with a unique hybrid drive. At over 37,000-lbs. gross weight, this is the largest vehicle to ever use ultracapacitor energy storage. The ultracapacitor technology utilized for the HETB is being applied to satellite actuation to replace unreliable hydraulic systems. The motor

and control technology utilized for the HETB is being applied to flywheel dynamometer systems.

HPM has been utilized to provide power for drop tower research. HPM is being considered for space missions, such as the exploration of Mars, and deep space missions, such as the exploration of Europa.

Through the NASA Glenn Research Center Commercial Technology Office, HPM is being applied to power generation, transportation, safety, and biotechnology systems. Some specific examples include photovoltaic power generation, electric vehicles, safety flashers, and hearing aids.